REMARKS

Drawings

The drawings were objected to under 37 CFR 1.83(a) because the drawings must show every feature of the invention specified in the claims. The examiner noted features in claims 42 and 30-47 that are not shown in the drawings. The features specified by the examiner have been deleted from claims 42 and 30, and claims 31-47 depend from claim 30 (claim 32 and 45 deleted).

Claims

Objections

The examiner objected to claims 2, 25-29, 37 and 41 because of informalities. Claim 2 has been deleted and claims 25-29 and 41 have been amended pursuant to the examiner's suggestions. The examiner's comments regarding claim 37 have been noted and applicants did not amend this claim in that they are satisfied that the wording of the claim is as intended.

35 U.S.C. 112

Claims 30-47 were rejected under 35 USC § 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the art that the inventors, at the time of the application, had possession of the claimed invention. Claim 30 has been amended to remove the reference to "at least two pairs of oppositely doped layer . . ." Claim 32 has been canceled and claim 44 has been amended to remove the reference to "at least two pairs of electrical contacts."

Claims 2 and 16 were also objected to under this section. Claim 2 has been deleted and claim 16 has been amended to depend from independent claim 14 (as amended), with both claim 14 and 16 referring to an active region.

Claims 38 and 39 were also objected to under this section and claim 38 has been amended so that said red light is from said substrate. The examiner's comments have been noted as they apply to claim 39, but the language quoted by the examiner cannot be found in claim 39. Clarification is respectfully requested.

35 U.S.C 102(e)

The examiner rejected claims 1-9, 14-16 and 24-29 under 35 U.S.C. 102(e) as being clearly anticipated by Kaneko (U.S. Patent No. 6,239,901). The examiner also rejected claims 1-8, 14, 16, 18 and 24-29 as being anticipated by Japanese Disclosure No. JP '203.

Claims 1, 2, 3, and 8 have been deleted. As described below, claim 14 has been amended in independent form to include patentably distinct features over these references and claims 4-7, 15, 16, and 24 have been amended to depend from claim 14. Claim 25 has also been amended to include patentably distinct features and claims 26-29 depend from claim 25.

Kaneko

As fully outlined in applicants' response to the examiner's first office action, the present application discloses embodiments of an LED that are patentably distinct from Kaneko. Kaneko discloses a hybrid laser device in which the excitation source and solid-state laser

are fabricated in the same device in precise alignment with one another. [col. 1, lines 14-50]. In each of the embodiments, the light source provides light to the laser's optical substrate. Mirrors are included on the substrate to reflect the light within the substrate to generate stimulated coherent laser light emission.

The embodiment shown in FIG. 2 of Kaneko is an edge emitting light source 1 that includes a solid state laser 912 with an LED emitter on top of it. The laser 912 is formed of an Al_2O_2 crystal substrate 11 having end face mirrors 121, 122 and a bottom mirror 123. Cr^{3+} is doped in the crystal substrate 11, which acts as the solid state laser. Light is generated in LED 912 and light from the LED 912 passes into the optical crystal substrate 11 where it undergoes wavelength conversion. The light then reflects between the mirrors 121, 122 to produce stimulated emission of the light L_{12} through mirror 121. [col. 3, line 7 to col. 4, line 18]. Kaneko notes that although an LED is used as the light emitter, a laser can be used in its place. [col. 4, lines 43-47]. However, regardless of which light source is used, the light is first generated and then passes into the optical crystal where the mirrors cause stimulated laser emission.

The other embodiments disclosed in Kaneko essentially have the same features with small variations. For instance, the embodiment in FIG. 3 is the same as FIG. 2 except that it has top and bottom mirrors 222, 221 and the stimulated emission of light L_{22} passes from the device 2 through the bottom mirror 221. The embodiment in FIG. 4 is the same as FIG. 3 with a variation to the LED 932 on the optical crystal. A convex lens 35 is included between the LED 932 and the optical crystal. The only difference in the embodiment of FIG. 5 is that is shows a solid-state laser

942 used in place of an LED to provide light that pumps the solid state laser 941 below it. Similarly, the embodiment shown in FIG. 7 uses a laser emitter 962 that is arranged in a notch in the optical crystal 61. The optical crystal 61 between mirrors 622 and 621 functions as the laser crystal causing stimulated emission from mirror 621. The embodiments in FIGs. 8, 9 and 10 provide variations of the light emitter in FIG. 7.

All of the embodiments have one feature in common, they all rely on a light source applied to an optical substrate with mirrors to generate stimulated emission. Even Kaneko's independent claim 1, from which all other claims depend, requires that the light source have mirrors. Kaneko does not disclose, teach or suggest an LED with a doped substrate where the substrate does not have mirrors to provide laser emission. As more fully described below, applicants' respectfully submit that Kaneko is not applicable to the applicants' claimed[1] invention.

The Japanese reference JP '203 discloses a light emitter on a substrate doped with an element that emits red, green, or blue, after absorbing UV light. The color that the substrate emits depends on the type of element in the substrate. The different embodiments shown include an LED formed on the doped substrate (FIG. 2), a double heterostructure LED 22 on the doped substrate (FIG. 3), and a double heterostructure LED 22 on a doped substrate with a mirror 31 (FIG. 4)

---

1 It appears that the examiner did not consider applicants arguments outlined in response to the examiner's first office action because in the examiner's opinion, applicants argued only differences between the present invention as described in the specification. Applicants respectfully submit that the claimed invention was fully argued in the response and respectfully request that the examiner give full consideration to applicants' arguments herein.

Each of the embodiments are designed to emit either red green or blue. None of the embodiments teach or suggest a single device with multiple emitting layers that emit at the same time or can be individually controlled to emit light alone or in combination with other emitting layer. None of the embodiments teach or suggest using a plurality of dopants in the single device substrate to cause the LED to emit different colors of light.

Applicants' claimed invention discloses numerous LED embodiments having patentable features that are not taught or suggested by Kaneko or JP '203. Some of these include:

> An LED with an active region and doped layers disposed successively on said substrate such that said substrate absorbs at least some of said light from said active region, said substrate doped with a plurality of impurities such that it absorbs the light of said active layer and re-emits more than one color of light. (Claim 14)
>
> The plurality of impurities can be rare earth or transition elements in color centers (Claim 16)
>
> The LED can include a means for selectively applying a bias to a portion of the active region above each of said color centers to generate light that is primarily absorbed by the color center. (Claim 52).
>
> The active region can be multiple quantum wells or single quantum wells. (Claim 4)

Other patentable features include:

An LED having a plurality of active layers each of which is capable of emitting light at a predetermined wavelength and includes a means for selectively causing each of said plurality of active layers to emit light alone or in combination with others of said plurality of active layers. A doped substrate, said plurality of active layers arranged vertically on said substrate such that said substrate absorbs at least some of said light from at least one of said plurality of active layers and re-emits light at a different wavelength. (Claim 30).

Like above the substrate can have different impurities to cause it to emit different colors and the impurities can be in color centers. (Claim 36 and 43).

The active layers can be arranged to emit different colors of light at the same time or independently. (Claims 38-41).

These are only some of the patentable features included in the applicants' claims and supported in the specification. Kaneko and JP '203 do not anticipate these claims because they do not have all of the elements of these claims. "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently as described, in a single prior art reference. (citation) the identical invention must be shown in as complete detail as contained in the . . . claim (citation)" MPEP 2131

Further, the claims are not obvious over Kaneko and JP '203 because the references do not disclose teach or

suggest these features. In the absence of any showing in the prior art references, "it is impermissible to use the claimed invention to serve as an instruction manual or template to piece together the teachings of the prior art to that the claimed invention is rendered obvious." In re Fritch, 23 U.S.P.Q.2d 1780 (Fed. Cir. 1992). "The mere fact that the prior art could be so modified would not have made the modification obvious unless the prior art suggested the desirability of the modification." In re Gordon, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984).

35 U.S.C 103(a)

The examiner rejected claims 30-37, 41 and 43-45 under 35 U.S.C. 103(a) as being obvious over Kaneko, in view of Chen '681. As outlined above, Kaneko addresses a completely different type of device that includes a light source to provide light to an optical substrate that uses mirrors to generate stimulated coherent emission. Further, the examiner relied on FIGs. 4 and 6 in Chen, which show multiple light emitting devices arranged adjacent to one another. In contrast, claim 30 (as amended) has its active layers arranged vertically and successively on the substrate. Further, in claim 54 includes the limitation of doped layers between the stacked active layers. Chan and Kaneko do not disclose teach or suggest vertically arranged multiple active layers on a doped substrate. Claim 30 is not obvious over these references and claims 31-37, 41, and 43-47 (claims 32 and 45 deleted) depend from claim 30 and are not obvious.

Claims 30, 31, 33-37, 41, 43, 45 and 47 were rejected under this section as being obvious over Kaneko in view of Bojarczuk, Jr. et al. '185. Like Chen, Bojarczuk discloses

LEDs arrayed adjacent to one another on a common substrate and for the same reasons as in the previous paragraph, the claims are not obvious over these references.

Claims 9 and 15 were rejected under this section as being unpatentable over JP'203 as applied to the claims above and further in view of Kaneko. Claim 15 has been amended to depend from amended claim 14 and for the reasons outlined above claim 15 is allowable over these references. In rejecting claim 9, the examiner correctly notes the JP '203 does not disclose or suggest a yellow emitting LED or the Co may be used as a dopant. Applicants also analyzed Kaneko and could not find a reference to a yellow emitting InGaN LED. Applicants submit that Kaneko has no reference and accordingly, applicants request reconsideration of the rejection and allowance of claim 9.

Claims 38-40 were rejected under this section as being obvious over Kaneko-Bojarczuk or alternatively Kaneko-Chen, and further in view of Thompson et al. '489. However, Thompson uses double heterostructure organic light emitting devices and there is no suggestion or teaching that such technology can, or should be, equally applicable to epitaxial light emitting diodes. More importantly, the devices in Thompson are arranged adjacent to one another like the devices in Bojarczuk and Chen. In claim 30 as amended, the active layers are vertically arranged on the substrate and the LED includes a means for separately illuminating each of the active layers. The references do not teach the underlying principals of the embodiments in these claims. The vertical arrangement of these claims, as well as the multiple emitting colors, and substrate impurities are not taught or suggested by the references.

The examiner also objected to claim 42 under this section as being obvious over Kaneko-Bojarczuk or alternatively Kaneko-Chen, and further in view of Birkhahn et al. '669. As outlined above, claim 42 has been amended to delete the reference to iron.

The examiner rejected claim 46 under this section as being unpatentable over Kaneko-Chen-Thompson, and further in view of Applicant's admitted prior art. Claim 46 depends from claim 30 in which the active layers are vertically arranged on the substrate. The cited references do not teach or suggest these limitations. Further, these references do not disclose, teach or suggest the combination of a blue light emitting active layer and a UV-emitting active layer, with some of the blue light absorbed by a downconverting material and re-emits yellow light and the UV light being absorbed by a substrate and re-emitted as red light.

Added claims

Claims 52 and 53 were added to claim the features of the invention related to a bias selectively applied to the device's active region above the color centers. Support for these claims can be found in the specification on page 12, line 11 to page 13, line 22 , and in FIG. 5.

Claims 54 and 55 were added to claim the features of invention related to a separately biasing the active layers in a multiple active layer device. Support for these claims can be found in the specification on page 9, line 7 to page 11, line 7, and in FIG. 2.

All of the claims in the application are now believed to be in proper form for allowance, and a Notice of Allowance is respectfully requested.

A petition for a two month extension of time to file this response is filed concurrently.

Respectfully submitted,

October 2, 2002

Jaye G. Heybl
Attorney for Applicants
Registration No. 42,661

KOPPEL JACOBS PATRICK & HEYBL
555 St. Charles Drive, Suite #107
Thousand Oaks, CA 91360
(805)373-0060

VERSION WITH MARKINGS TO SHOW CHANGES MADE

Specification

Specification page 9, line 32 to page 10, line 6:

With a bias applied across the n-type contact 31 and all p-type contacts 27, 28, and 29 (usually in the range of 3 to 4 volts), each of the active layers 21, 22 and 23 [will] emit light omnidirectionally. Green, blue and UV light [will be emit] emits through the surface of the LED 20 and will also pass into the ruby substrate 32. The Cr in the substrate 32 will only absorb the UV light and as the Cr electrons return to their equilibrium state, they will emit red light. Some of the red light will emit from the LED's surface along with the green, blue, and UV light, all of which will combine to produce white light.

Specification page 11, lines 8-26:

White light can also be produced by a new LED generating only one color of light from its active layer, by doping the substrate with more than one rare earth or transition element. FIG. 3 shows another embodiment of the new LED 34 being nitride based and having a UV emitting multiple quantum well active layer 35 made of InGaN, although other types of active layers can also be used. It is sandwiched between a GaN n-type layer 36 and a GaN p-type layer 37. When a bias is applied across the p-type contact 39 and n-type contact 40, the active layer 35 [will emit] emits UV light with some of it emitting from the LED surface and some of it passing into the substrate 38. The substrate 38 is doped with Cr which absorbs UV light and emits red light, Titanium (Ti) which absorbs UV light and emits blue light, and Cobalt (Co) which absorbs UV light

and emits green light. The red, green, and blue light [will be] is emitted from the substrate omnidirectionally, with some of it emitting from the LED's surface to produce white light.

Claims

4. (Amended) The [light emitting device] LED of claim [1] 14, wherein said active [layer] region [includes] comprises multiple quantum wells [,] or single quantum wells [or double heterostructure].

5. (Amended) The [light emitting device] LED of claim [1] 14, wherein said substrate comprises a material from the group consisting of sapphire, spinel, silicon carbide, gallium nitride, quartz YAGI, garnet, lithium gallate, lithium niobate, zinc oxide, [or] and oxide single crystal.

6. (Amended) The [light emitting device] LED of claim [1] 14, wherein said substrate is doped with [at least one] a plurality of rare earth or transition [element] elements.

7. (Amended) The [light emitting device] LED of claim [1] 14, wherein said substrate is doped with [at least one impurity] a plurality of impurities from the group consisting of chromium, titanium, iron, erbium, neodymium, praseodymium, europium, thulium, ytterbium and cerium.

9. (Amended) A light emitting diode (LED), comprising:

an active layer;

a pair of oppositely doped layers on opposite sides of said active layer which cause said active layer to emit omnidirectional light at a predetermined

wavelength in response to an electrical bias across said doped layers; and

a doped substrate, said active and doped layers disposed successively on said substrate such that said substrate absorbs at least some of said light from said active layer and re-emits omnidirectional light at a different wavelength, said LED emitting a combination of light from said substrate and said active layer, [The light emitting device of claim 1],wherein said active layer emits yellow light and said substrate comprises sapphire doped with chromium, said substrate absorbing some of said yellow light and re-emitting red light.

14. (Amended) A light emitting diode (LED), comprising:

an active region;

a pair of oppositely doped layers on opposite sides of said active layer which cause said active region to emit light at a predetermined wavelength in response to an electrical bias across said doped layers; and

a doped substrate, said active region and doped layers disposed successively on said substrate such that said substrate absorbs at least some of said light from said active region, [The light emitting device of claim 1, wherein said active layer emits one color of light,] said substrate doped [throughout] with [more than one impurity] a plurality of impurities such that it absorbs the light of said active layer and re-emits more than one color of omnidirectional light.

15. (Amended) The [light emitting device] LED of claim [1]

14, wherein said active [layer] region emits UV light and said substrate is doped throughout with chromium, titanium, and cobalt, said doped substrate absorbing said UV light and emitting red, green, and blue light.

16. (Amended) The [light emitting device] LED of claim [2] 14, wherein said active [layer] region emits UV light, and said substrate is doped with [one or more] a plurality of rare earth or transition [element] elements in a plurality of separate color centers that each [absorb] absorbs UV light and [re-emit] re-emits a different color of light[, said bias selectively applied to a portion of said active [layer] region above said color centers causing said active layer to emit light that will be primarily absorbed by said color center below said selectively biased portion of said active layer and re-emitted as a different color].

24. (Amended) The [light emitting device] LED of claim [1] 14, wherein said doped substrate is doped using solid state diffusion, ion implantation, beam evaporation, sputtering, or laser doping.

25. (Amended) A method for generating light from a solid state light emitting device, comprising:

providing a light emitting diode having an active layer surrounded by a pair of oppositely doped [layer] layers, all of which are disposed on a doped substrate that is doped with a plurality of impurities;

exciting an optical emission from said active layer within a first wavelength range;

applying at least a portion of said optical emission to stimulate emission from said doped substrate within [a]

different wavelength [range] ranges depending on said plurality of impurities; and

transmitting a combination of said optical emission and substrate emission as said LED's light.

27. (Amended) The method of claim 25, wherein said substrate is doped with [at least one] a plurality of rare earth or transition [element] elements.

28. The method of claim 25, wherein said substrate is doped with [at least one impurity] a plurality of impurities from the group consisting of chromium, titanium, iron, erbium, neodymium, praseodymium, europium, thulium, ytterbium and cerium.

29. The method of claim 25, wherein said doped substrate is doped using solid state diffusion, ion implantation, beam evaporation, sputtering, or laser doping.

30. (Amended) A [solid state light emitting device] light emitting diode (LED), comprising:

[at least two] a plurality of active layers each of which is capable of emitting light at a predetermined wavelength;

[at least two pairs of oppositely doped layers, each of said active layers sandwiched between one of said pairs of oppositely doped layers, each of said pairs of oppositely doped layers causing its respective one of said active layers to emit light at a predetermined wavelength in response to an electrical bias across of said at least two pairs] a means for selectively causing each of said plurality of active layers to emit omnidirectional light alone

or in combination with others of said plurality of active layers; and

a doped substrate, said plurality of active layers arranged vertically [and said pairs of oppositely doped layers disposed] on said substrate such that said substrate absorbs at least some of said light from at least one of said plurality of active layers and re-emits omnidirectional light at a different wavelength.

31. (Amended) The [light emitting device] LED of claim 30, that emits a combination of light from said plurality of active layers and said substrate.

33. (Amended) The [light emitting device] LED of claim 30, wherein each of said plurality of active layers comprises multiple quantum wells, single quantum wells or double heterostructures.

34. (Amended) The [light emitting device] LED of claim 30, wherein said substrate comprises a material from the group consisting of sapphire, spinel, silicon carbide, gallium nitride, quartz YAGI, garnet, lithium gallate, lithium niobate, zinc oxide, [or] and oxide single crystal.

35. (Amended) The [light emitting device] LED of claim 30, wherein said substrate is doped with at least one rare earth or transition element.

36. (Amended) The [light emitting device] LED of claim 30, wherein said substrate is doped with at least one impurity from the group consisting of chromium, titanium, iron, erbium, neodymium, praseodymium, europium, thulium,

ytterbium and cerium.

37. (Amended) The [light emitting device] LED of claim 30, wherein the light emitting from said [device] LED comprises the light emitting from at least one of said plurality of active layers or the light emitting from at least one of said plurality of active layers in combination with the light emitted from said doped substrate.

38. (Amended) The [light emitting device] LED of claim 30, [comprising a LED,] wherein said plurality of active layers comprising three active layers emitting blue, green and UV light respectively, said substrate comprising sapphire doped with chromium which absorbs said UV light and re-emits red light, said LED emitting blue, green, UV and red light from said substrate, in a white light combination, when all said active layers are emitting[, in a white light combination].

39. (Amended) The [light emitting device] LED of claim 30, [comprising an LED] wherein said plurality of active layers comprises three active layers emitting blue, green and UV light respectively, wherein each of said active layers can selectively emit light, said LED emitting primarily red, green, or blue light when one of said active layers is emitting, or said LED emitting primarily purple, aqua, yellow, or white light when more than one of said active layers is emitting.

40. (Amended) The [light emitting device] LED of claim 30, [comprising a LED,] wherein said plurality of active layers comprises two active layers emitting blue and yellow light respectively, said substrate doped with chromium such that

it absorbs at least some of said yellow light and emits red light.

41. (Amended) The [light emitting device] LED of claim 30, [comprising a LED,] wherein said plurality of active layers [emitting] emit one color of light, said substrate doped throughout with [more than one impurity] a plurality of impurities such that said [it] substrate absorbs the light from said active layers, and [re-emit] re-emits more than one color of light.

42. (Amended) The [light emitting device] LED of claim 30, [comprising a LED] wherein said plurality of active layers emit UV light and said substrate is doped throughout with chromium, titanium, [iron,] and cobalt, said doped substrate [absorbs] absorbing said UV light and [emits] emitting red, green, and blue light.

43. (Amended) The [light emitting device] LED of claim 30, [comprising an LED] wherein said plurality of active layers emit UV light, and said substrate is doped by one or more rare earth or transition element in a plurality of separate color centers [that absorb] each of which absorbs UV light and [re-emit] re-emits a different color of light[, said bias selectively applied to said active layers above said color centers causing said active layers to emit light that will be primarily absorbed by said color center below said active layers and re-emitted as a different color].

44. (Amended) The [light emitting device] LED of claim 43, [further comprising at least two pairs of electrical contacts each of said at least two pairs of electrical contacts arranged to apply a bias across a respective one

of said pairs of oppositely doped layers above said color centers] further comprising a means for selectively applying a bias to a portion of said plurality of active layers above each of said plurality of color centers causing said active layer to emit light that is primarily absorbed by said color center below said selectively biased portion of said active layer and re-emitted as a different color.

46. The [light emitting device] LED of claim 30, [comprising a LED] wherein said plurality of active layers emit blue light and UV light, said substrate [absorbs] absorbing at least some of said UV light and [re-emits] e-emitting red light, said LED further comprising downconverting material around the surface of said LED that absorbs some of said blue light emitting from that surface and re-emits yellow light.

47. The [laser] LED of claim 30, further comprising electrical circuitry integrated with said [device] LED on a common substrate.